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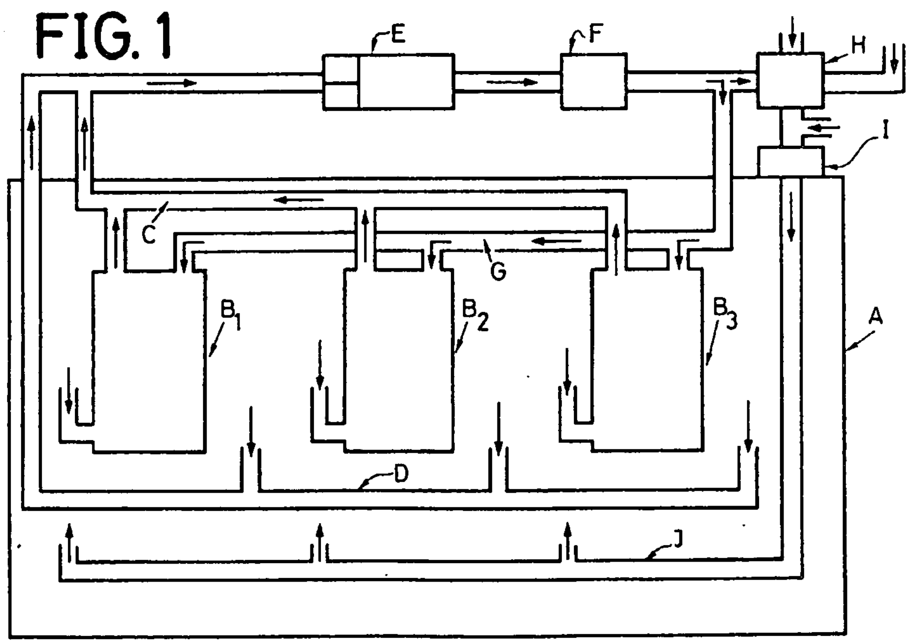
(54) An Energy Recovery System for Use on a Printing Press or the Like

(57) Solvents evaporated in the dryer sections B1, B2, B3 of a multi-station printing press or the like are removed from the dryer exhaust by heating the dryer exhaust C in an oxidation chamber E. The oxidation chamber exhaust is utilised, as a source of heat for the air supplies of the dryers, a regulated portion of the heated oxidation chamber exhaust being recirculated to the dryer sections to form a portion of the air supplies thereof. The recirculated oxidation chamber exhaust is confined within a completely enclosed system to prevent exposure of the pressroom personnel thereto. In addition, a heat exchanger may be utilised to transfer a portion of the remaining heat from the non-recirculated portion of the oxidation chamber exhaust to fresh air in order to heat the pressroom.

FIG. 1



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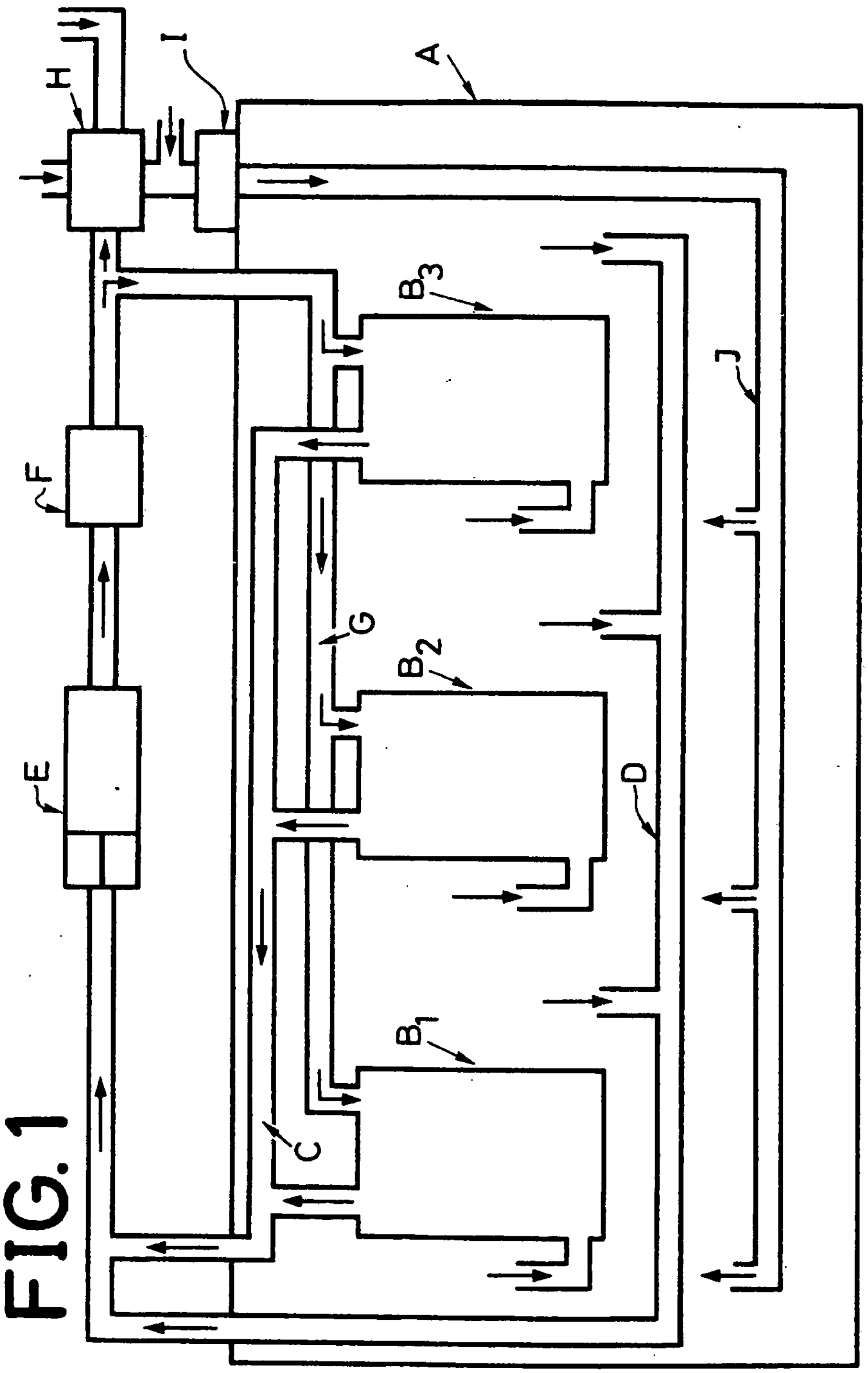
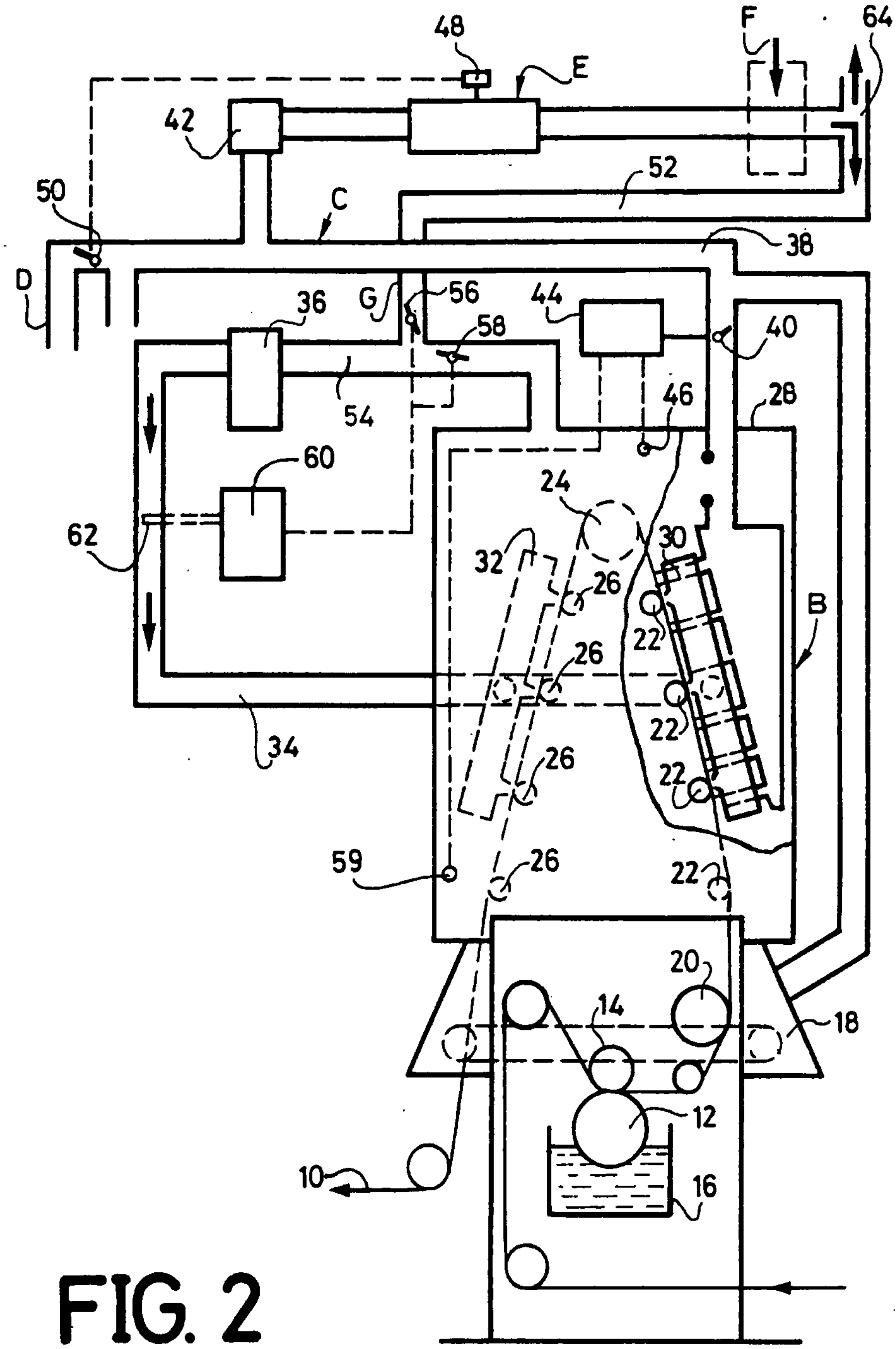


FIG. 1


48
E
F
64
42
52
50
C
38
D
36
G
56
44
58
40
54
46
28
60
24
62
32
30
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B
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22
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34
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59
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10
16

FIG. 2

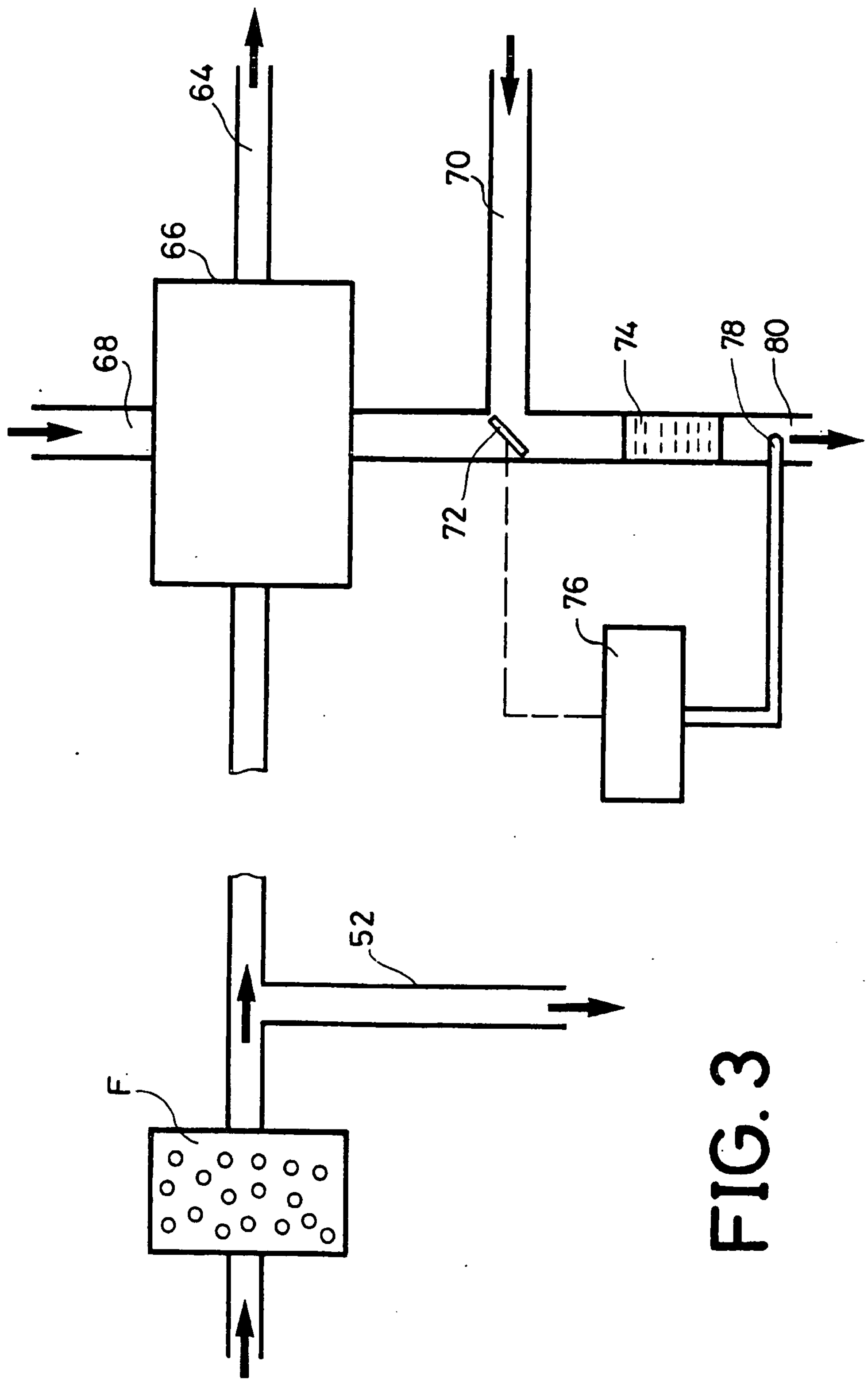

FIG. 3

SPECIFICATION

An Energy Recovery System for Use on a Printing Press or the Like

The present invention relates to an energy recovery system for use in conjunction with a printing press or the like, and in particular, to a system wherein the heat from the exhaust of the oxidation chamber is utilized, without a heat exchanger or intermediate transfer medium, to facilitate solvent evaporation in the dryer sections of the printing press, in an economically feasable and safe manner.

Rotogravure packing/printing presses are currently widely used by packaging/printers. Air pollution standards require that the solvents present in the exhaust of such presses be removed prior to introduction of the exhaust to the environment.

As is explained in detail in Application Serial No. 814145, filed July 11, 1977, and entitled: "Method and Apparatus for Conservation of Energy in a Thermal Oxidation system for Use with a Printing Press", solvents evaporated from ink solutions in the drying sections of a printing press can be converted into harmless carbon dioxide and water vapor by heating the dryer exhaust, for a given time period, to a temperature above the oxidation temperature of the solvents.

The amount of energy required to maintain the oxidation process may be substantially reduced by pre-heating the solvent laden exhaust, through the use of a pebble bed heat regenerator, or other pre-heater, to the ignition temperature of the solvent, prior to the introduction of the exhaust into the oxidation chamber. If the dryer exhaust contains a relatively high solvent concentration and is preheated above the solvent ignition temperature, the solvent itself will provide sufficient heat of combustion to maintain the oxidation process.

With this degree of preheat, at relatively high solvent concentration levels, not only is no additional fuel required, but excess heat is generated during the oxidation process. In order to maintain the system at the minimum fuel consumption level and limit the maximum temperature generated, which may deteriorate the oxidation chamber structure, and therefore shorten the useful life thereof, a portion of the preheat section may be bypassed as necessary by a regulated amount of dryer exhaust, such that the temperature in the oxidation chamber is controlled and maintained at an acceptable level.

Alternatively, the solvent concentration level of the exhaust can be lowered by mixing the dryer exhaust with the floor sweep exhaust (of substantially lower solvent concentration) in regulated proportions, to control the heat of combustion generated by the solvents, and thus, the oxidation chamber temperature. This method has the advantage of providing floor sweep capability without increased cost. Further, the use of solvent concentration (LEL) controls in the dryer sections can enhance the accuracy of the concentration control at the intake of the oxidation apparatus and substantially reduce the size of the oxidation chamber by reducing the volume of the dryer exhaust to be processed.

In the above identified application, the exhaust from the oxidation chamber is vented directly to the atmosphere. This exhaust is at a temperature of between 200°—400°F, and therefore, contains a large amount of useable heat. However, this exhaust may not be used in any manner which would cause the pressroom personnel to be exposed thereto, because same may still contain sufficient concentrations of evaporated solvents to be harmful to personnel exposed to the exhaust, especially in an enclosed area, such as a pressroom.

Within each of the dryer sections of the press, the air supply is heated in order to facilitate evaporation of the solvents from the web, as same passes through the dryer. The heating of the air supply for the dryer sections requires additional apparatus and a significant amount of energy. The energy normally required to heat the air supply in the dryer sections could be supplied by the exhaust from the oxidation chamber. However, from a practical standpoint, this objective is difficult to achieve without exposing the pressroom personnel to the oxidation chamber exhaust.

Theoretically, it would be possible to use heat exchangers and an intermediate transfer medium, such as oil, to transmit the heat from oxidation apparatus exhaust to the air supply of the dryer sections. This type of system would solve the problem of exposure of pressroom personnel to the hazardous exhaust fumes. However, such systems are energy inefficient, costly to purchase and maintain and may create other safety problems. Heat exchangers, oil pumps and insulated conduits to carry the hot oil under pressure are all expensive to buy and install and require continuous maintenance and repair. Further, any leakage of hot oil cannot be tolerated, as same may create a safety hazard. Moreover, each time the heat is transferred from one medium to another, substantial energy losses occur. Thus, the inefficiency and costs of such oil systems may outweigh the costs of the energy required to heat the air supplies to the dryers and therefore, make the system economically impractical.

Further, not all of the heat in the oxidation chamber exhaust is required in order to raise the dryer air supplies to the appropriate temperature level. It is therefore possible to utilize a portion of the remaining heat from the oxidation chamber exhaust, by means of a single heat exchanger and fresh air as a transfer medium, to heat the pressroom.

It is, therefore, a primary object of the present invention to provide an energy recovery system for use with a printing press or the like wherein heat from the exhaust of the oxidation apparatus is utilized, directly, in an economically efficient manner, in the press dryer sections to facilitate

solvent evaporation therein.

It is a second object of the present invention to provide an energy recovery system for use in a printing press or the like wherein the heat from the oxidation exhaust is utilized in a completely safe manner.

It is another object of the present invention to provide an energy recovery system for use in a printing press or the like wherein the necessity for using heat exchangers and intermediate transfer mediums to obtain and transfer the heat from the oxidation apparatus exhaust is eliminated by recirculating the oxidation apparatus exhaust to the dryer sections in a completely enclosed system.

It is a further object of the present invention to provide an energy recovery system for use in a printing press or the like wherein pressroom personnel are not exposed to the potentially hazardous fumes in the oxidation apparatus exhaust as the exhaust is recirculated to heat the dryer sections' air supplies.

It is still another object of the present invention to provide an energy recovery system for use in a printing press or the like wherein the heated air supply to the dryer sections, which comprises the recirculated exhaust from the oxidation chamber, is introduced directly at the surface of the web to reduce the vapor pressure at the web surface thereby facilitating evaporation.

It is a still further object of the present invention to provide an energy recovery system for use in printing presses or like wherein a single heat exchanger can be utilized to transfer the heat content of the non-recirculated oxidation apparatus exhaust to a stream of fresh air which is thereafter utilized to heat the pressroom.

In accordance with the present invention, an apparatus and method of energy recovery is provided for use in a solvent evaporation system for a printing press or the like of the type having enclosed dryer sections wherein heated air is utilized to evaporate the ink solvents on the printed web. Solvent oxidation means, preferably in the form of a pebble bed heat generator preheater, in combination with a oxidation chamber, is utilized to remove the evaporated solvents from the solvent laden exhaust of the dryer sections. Means are provided for drawing the exhaust from the dryer section enclosures and for transferring same to the oxidation means. A regulated portion of the oxidation means exhaust is recirculated to the air supply for the dryer section enclosures so as to utilize a portion of the heat generated during the oxidation process to promote solvent evaporation within the dryer, thereby eliminating the necessity of additional apparatus and energy to heat the air supply to the dryer section enclosures. Since the oxidation means exhaust is used as a heat transfer medium, no heat exchangers or intermediate transfer mediums are required.

The recirculated exhaust from the oxidation chamber is confined in a completely enclosed system. Thus, the possibility of exposure of pressroom personnel to the potentially dangerous fumes of the exhaust is eliminated. With this system, no heat is lost in raising the temperature of the air supply for the dryer sections, as the oxidation means exhaust is used directly, without any conversions between different mediums.

Preferably, means are provided for sensing the temperature within the dryer sections and for regulating the flow of exhaust from the oxidation means to the dryer sections, in accordance with the sensed temperature. That portion of the exhaust from the oxidation means which is not recirculated, is vented to the atmosphere. Prior to venting the non-recirculated exhaust from the oxidation chamber, this portion of the exhaust may be passed through a heat exchanger, wherein the heat thereof is transferred to a stream of fresh air, which is subsequently utilized to heat the pressroom.

Since the temperature of the exhaust from the oxidation chamber may vary within the range of approximately 200°F—400°F, it is preferable to utilize a heat averaging means, such as a single pebble bed chamber of the like, through which the oxidation chamber exhaust passes prior to entering the recirculation system. Such a device will serve to stabilize the temperature of the recirculating exhaust. This temperature averaging means is preferably located at the outlet of the oxidation chamber.

The rate of solvent evaporation from the ink web within the dryer sections is a function of the temperature and vapor pressure at the web surface. The temperature at the web surface is regulated by means of the temperature sensing apparatus, referred to above, which regulates the portion of the oxidation chamber exhaust which is recirculated. The vapor presssure in the area immediately adjacent the web surface is maintained at acceptably low levels by introducing the heat dryer air supply, which consists, in large part, of the recirculated exhaust from the oxidation means, at a point within the dryer enclosure immediately adjacent the web surface. The high flow of heated air at this point significantly reduces the vapor pressure at the web surface thereby facilitating evaporation.

To the accomplishment of above and to such other objects which may hereinafter appear, the present invention relates to an energy recovery system for use with the printing press or the like, as recited in the annexed claims and described in this specification, taken together with the accompanying drawings, where like numerals refer to light parts, and in which:

Figure 1 is a schematic diagram of a thermal oxidation system used in conjunction with the dryer sections of a printing press, showing the exhaust recirculation system and pressroom heating system of the present invention;

Figure 2 is a more detailed schematic diagram of certain portions of the recirculation system of the present invention, showing some of the structural features of a printing press dryer section, utilized in conjunction therewith;

Figure 3 is a schematic diagram showing in greater detail the heat averaging apparatus, the heat exchanger and the temperature control system for the pressroom heating system.

Figure 1 shows schematically the pressroom, generally designated A, in which is situated a multi-color, multi-section rotogravure printing/packaging press. For purposes of illustration, only three dryer sections, generally designated B1, B2 and B3, respectively, are depicted. However, it is to be understood that the present invention can be utilized with presses having any desired number of stations As is described in greater detail below, in each section of the printing press, ink is applied to a continuous web of material, such as newsprint or thin cardboard. The ink contains one or more organic solvents which must be removed from the web in order to dry same. This is accomplished in each stage of the press in a dryer section through which the web passes immediately after inking. Each dryer section comprises a completely enclosed area in which the evaporation of the organic ink solvents take place. The dryer enclosures are designed to prevent the escape of the solvent laden air into the pressroom such that pressroom personnel are not exposed to the hazardous fumes therein.

A regulated amount of exhaust from each of the dryer sections B1, B2 and B3, is drawn from the respective enclosures by means of a fan or blower (not shown in Figure 1), located in an exhaust conduit system, generally designated C. This fan or blower is also utilized to draw air through the pressroom floor sweep ventilation system, generally designated D, which may be utilized to continuously remove evaporated solvents from the pressroom floor or only during pressroom cleanup, after the press has been shut down, as desired. The air flow through the floor sweep ventilation system D is regulated by means of a damper (not shown in Figure 1) situated in the main conduit of that system.

The solvent laden air from the dryer exhaust system C and pressroom floor sweep system D is directed to the intake side of the thermal oxidation apparatus, generally designated E. Apparatus E preferably comprises a preheat section and an oxidation section. A non-metallic preheater is utilized to preheat the incoming solvent laden air to the solvent ignition temperature, causing the solvent to generate its heat of the combustion. The preheated exhaust is then introduced into the oxidation chamber. By regulating the amount of heat of combustion, the chamber temperature can be controlled to minimize fuel consumption and eliminate deterioration of the structure thereof. Regulation of the generated heat of combustion is achieved through the control of the application of preheat or of the solvent concentration of the incoming air. A portion of the heat from the exhaust gases from the oxidation chamber is recovered and utilized to perform the preheat operation.

As described in detail in the above identified application, the preheat section of apparatus E comprises first and second heat regeneration chambers, each of which contains a bed of heat exchanger elements or pebbles. The exhaust from the oxidation chamber is directed through one of the beds, such that some of the heat energy therein is absorbed by the heat exchanger elements. Thereafter, flow through the preheat section of apparatus E is reversed, incoming solvent laden air being directed through the previously preheated bed and thereafter into the oxidation chamber. The exhaust from the oxidation chamber is fed through the second pebble bed chamber in order to heat same. After a given amount of time, the heat stored in the first bed has been dissipated by preheating the incoming solvent laden air and the elements in the second bed have absorbed as much heat from the oxidation chamber exhaust as possible. At this point, flow through the preheat section is again reversed, the second, now heated bed, providing the preheat to the incoming air and the first bed collecting the exhaust heat. Thus, the pebble beds are alternately used as preheaters and heat collectors and roles thereof are reversed at appropriate time intervals in order to continuously preheat the incoming air without any additional external heat source.

As indicated above, when the heat of combustion of the solvents is utilized within the oxidation chamber, more heat than is required to maintain the oxidation process will be generated, as long as the solvent concentration level is sufficiently high. Even though a portion of the heat of the exhaust of the oxidation chamber is recovered by the pebble beds, for use as a source of preheat for the incoming solvent laden air, the exiting exhaust still has a temperature within the range of between 200°F—400°F. This exhaust is normally vented directly to the atmosphere and therefore in conventional systems this heat energy is lost.

In the system of the present invention, however, the heat energy from the exhaust of the oxidation apparatus E is utilized to heat the dryer air supply, so as to facilitate solvent evaporation within the dryer enclosures B1, B2 and B3. This eliminates the neccessity for additional, individual heating units, normally connected to each of the dryer sections to heat the air supply thereto. As shown in Figure 2, the exhaust from the oxidation apparatus E travels through a temperature averaging apparatus, generally designated F, and thereafter a regulated portion thereof is introduced into a recirculation duct, generally designated G, which in turn feeds each of the dryer sections B1, B2 and B3 to heat the air supplies therein. Temperature averaging apparatus F serves to eliminate temperature fluctuations which occur in the oxidation apparatus exhaust, so that the output there from is maintained at a relatively constant temperature of, for example, 300°F.

Only a portion of the output from temperature apparatus averaging means F is directed through

recirculating duct G because only a portion of the heat contained in output of temperature averaging apparatus F is required to heat the air supply for the dryers. The remainder, or non-circulated portion, of the output of temperature averaging apparatus F is preferably directed through a heat exchanger, generally designated H, and is thereafter vented to the atmosphere. A stream of fresh air is directed through heat exchanger H and the heat in exchanger H is transferred thereto. The heated fresh air is mixed in regulated proportions with non-heated fresh air, in a mixer, generally designated I. The output from mixer I is fed, by means of a duct system, generally designated J, to the pressroom so as to provide forced hot air heating.

It should be noted that each of the dryer sections B1, B2 and B3 also has a fresh air inlet from the pressroom. This inlet is required to supplement the air supply with additional fresh air to replace that portion of the dryer exhaust which is removed from the dryer by exhaust system C and which is not returned thereto by recirculation duct G. The air flow through the dryer sections is always controlled such that slightly more air is removed therefrom through exhaust system C than is returned thereto by recirculation duct G, such that small amounts of fresh air are continuously entering the dryer through the fresh air inlet. Since the pressure within the dryer section is always slightly less than the pressroom air pressure, solvent laden air from within the dryer sections is prevented from entering into the pressroom.

Thus, it can now be readily appreciated the dryer enclosure D, exhaust system C, oxidation apparatus E, temperature averaging apparatus F and recirculation system G comprise an air circulation system which is completely isolated from the pressroom. Potentially harmful evaporated solvents are prevented from entering the pressroom and causing a health hazard to the pressroom personnel. Further, since the evaporated solvents are heavier than air, and therefore theoretically accumulate along the pressroom floor, if any leakage does occur, the pressroom floor sweep system D can be conveniently utilized to eliminate any escaped evaporated solvents within the pressroom, thereby maintaining a completely safe environment for the pressroom personnel.

In the manner described above, unused heat energy from the oxidation apparatus is efficiently and safely utilized to heat the dryer air supply, without heat exchangers or intermediate heat transfer mediums, so as to eliminate the necessity for individual heaters within each of the dryers and conserve the energy normally required to operate same. This object is achieved in a relatively simple and inexpensive system which maintains a completely safe environment for pressroom personnel.

As an option, a single heat exchanger may be utilized to transfer heat from the non-recirculated portion of the oxidation apparatus exhaust to a stream of fresh air which is thereafter used in a forced hot air heating system in order to heat the pressroom. In this instance, since the air is actually introduced into the pressroom, a heat exchanger is required because the exhaust from the oxidation apparatus may be not be sufficiently solvent free to be introduced into an environment where personnel are functioning.

Figure 2 shows one stage or section of the printing press in greater detail. It is to be understood that the printing press may comprise any number of different stages and that the stage depicted in Figure 2 is merely representative of a typical stage. A web 10, such as newsprint or flexible cardboard, passes between a inking roller 12 and a pressure roller 14. The lower portion of inking roller 12 is immersed in an ink bath 16. The surface of the inking roller 12 is provided with a plurality of recesses or indentations which, as the roller 12 is rotated, pass through the ink bath 16 and retain a small quantity of ink therein. As roller 12 is further rotated, the recesses or indentations on the surface thereof come in contact with the surface of the web 10, as the web passes between the ink roller 12 and the pressure roller 14. At this point, the ink solution is transferred from the indentations on the inking roller 12 to the surface of web 10.

After being inked, the web is fed into the hood portion of 18 of dryer section B. Web 10 travels past idler roller 20 and follows an upward directed path along a set of idler rollers 22, to idler roller 24. The web then travels around idler roller 24 and downwardly along a second set of idler rollers 26. After passing the last idler roller 26, the web exits the dryer section and is fed to the next printing station.

Above hood section 18 is located the main dryer enclosure 28, within which the solvent drying process takes place. A pair of air ducts 30, 32 are situated a short distance from idler roller sets 22 and 26, respectively, so that the web can pass therebetween. Each of the ducts 30, 32 are provided with a plurality of openings, located immediately adjacent the surface of the web. Ducts 30 and 32 are connected to supply duct 34, through which heated air is supplied thereto. The heated air travels through ducts 30 and 32 and out of the openings therein, such that it is introduced at a position immediately adjacent the surface of the web. In this manner, the air flow at the surface of the web is kept at a relatively high rate, thereby substantially reducing the vapor pressure in this area. The reduction of the vapor pressure at the surface of the web contributes substantially to the evaporation process. The vapor pressure is further reduced by placing the entrance of the exhaust duct 38, 60 close to the web on the incoming side of the dryer where the highest solvent concentration exists. If the solvent is not removed at the web surface, the solvent vapor pressure will increase, slowing down the evaporation rate.

Supply duct 34 originates at the top of enclosure 28 and contains a fan or blower 36

therein. Fan or blower 36 causes the air within enclosure 28 to circulate through an internal recirculation loop, formed by supply duct 34, ducts 30 and 32 and the interior of enclosure 28.

An exhaust duct 38, which forms a portion of exhaust system C, originates in enclosure 28 and is utilized to draw a regulated portion of the solvent laden air from the enclosure. Within duct 38 is located an exhaust damper 40 which regulates the amount of solvent laden air which is drawn into exhaust system C by an exhaust fan or blower 42 present therein. Fan or blower 42 is preferably a constant suction, variable flow exhaust fan. Exhaust damper 40 is operably connected to an LEL control 44, of conventional design, many of which are commercially available. LEL control 44 is, in turn, connected to a solvent concentration level sensor 46, located within enclosure 28.

Solvent concentration level sensor 46 senses the level of the solvent concentration within enclosure 28 and generates an electrical signal which is proportional to the sensed solvent concentration level. The LEL control converts this electrical signal into a pneumatic output which regulates exhaust damper 40.

The temperature within the oxidation chamber in oxidation apparatus E is controlled either by bypassing a portion of the preheat section thereof, or by regulating the concentration level of the intake thereto. Figure 2 depicts this latter method. A temperature sensing device (not shown) is located within the oxidation chamber and generates an electrical signal, proportional to the sensed temperature, to temperature control 48. Temperature control 48 is operably connected to control a pneumatically operated damper 50, which regulates the proportions of air from dryer exhaust system C and from floor sweep system B which are introduced into the oxidation apparatus E.

The exhaust from oxidation apparatus E is fed into temperature averaging apparatus F, which preferably comprises a single bed of heat exchanger elements of the type which are situated in the preheat section of the oxidation apparatus E. Temperature averaging apparatus F provides an output of relatively constant temperature, even though the exhaust from the oxidation apparatus may vary in a range of between 200°F—400°F.

Temperature averaging apparatus F is connected to a duct 52 which forms recirculation system G. Duct 52 is, in turn, connected to a duct 54 which runs to Fan 36 and enclosure 28 of dryer section B. Located in duct 52 and duct 34, respectively, are a pair of pneumatically operated dampers 56 and 58. Dampers 56 and 58 work in a reciprocal manner such that as one of the dampers is opened the other damper is closed, to the same degree. Both of these dampers are pneumatically connected to a temperature control 60 which, in turn, is connected to a temperature sensing device 62 located within supply duct 34.

The purpose of temperature control 60 is to control the temperature of the air supply which is introduced at the surface of the web. This is accomplished by regulating the proportions of exhaust recirculated from the oxidation apparatus E, damper 56 dryer, 28, and air drawn through damper 58, which constitute the air supply to the dryer section. If the temperature of the air supply falls below the required level, temperature control 60 opens damper 56 and closes damper 58, such that a higher proportion of exhaust from oxidation apparatus E is introduced into enclosure 28. On the other hand, if the temperature of the supplied air is above the required level, temperature control 60 closes damper 56 and opens damper 58, removing the heat source from the dryer. It should be noted that for high heat requirements when damper 56 is mostly or completely closed and damper 58 is mostly open, it would be possible for the dryer to go positive. This is avoided by sensing the dryer 28 pressure through pressure probe 59 and automatically reducing the LEL level which in turn increases the exhaust rate maintaining a negative pressure in the dryer. The static pressure probe is commercially available from companies such as Fairchild Instrument and Dwyer. Controlling the LEL level is the preferred implementation. The exhaust damper can be directly controlled through the pressure probe 59 overriding the LEL control whenever the dryer pressure approaches a positive pressure.

As will be appreciated from the above explanation, the dryer exhaust and recirculation system is an entirely closed system, with the exception of the fresh air inlet located on hood 18 and a vent 64 to the atmosphere which is connected to duct 52. Thus, the amount of air which is released into the atmosphere by means of vent 64 is approximately equal to the amount of fresh air which is drawn through hood 18 into the system. By maintaining the pressure within enclosure 28 at a level slightly less than the pressure of the pressroom air, air from the pressroom can only be drawn into hood 18 but the solvent laden air within the dryer enclosure is prevented from leaking into the pressroom and therefore causing a harmful ffect on the personnel therein. Any solvent laden air which does leak into the pressroom theoretically will settle on the pressroom floor and be removed by the floor sweep system D.

In the manner described above, the heat from the exhaust of the oxidation apparatus E can be utilized directly to heat the air supply to the dryer section in order to facilitate evaporation therein. The heat recovery from the oxidation apparatus exhaust is achieved by an economical, highly energy efficient and completely safe manner, because no heat exchangers or intermediate transfer medium is required and the air flow is completely confined such that the solvent laden air is not present in any area where pressroom personnel are situated.

Since only a portion of the exhaust from the oxidation apparatus E is utilized in order to heat the air supply to the dryer, it is desirable to utilize

the heat in the non-circulated air in order to heat the pressroom. This system is illustrated in Figure 3. Instead of directly venting the non-recirculated portion of the oxidation apparatus exhaust through vent 64, the non-recirculated portion of the exhaust passes through a heat exchanger 66 prior to being introduced into the atmosphere by vent 64.

A pair of ducts 68, 70 draw fresh air from the environment. The air in duct 68 passes through heat exchanger 66, such that the heat from the non-recirculated portion of the oxidation apparatus exhaust is transferred thereto. At the intersection of duct 68 and 70 is provided a pneumatically operated damper 72, which regulates the proportion of heated air from duct 68 and non-heated air from duct 70 which are introduced into a mixing chamber 74. Damper 72 is operably connected to a temperature control 76 which, in turn, is connected to sensor 78 situated within a duct 80, which forms a portion of the pressroom heating system J.

Temperature control 76 regulates the temperature of the forced hot air in the pressroom heating system J by regulating the amounts of heated and non-heated fresh air which are introduced into mixing chamber 74. Mixing chamber 74 comprises a series of baffles or the like which cause turbulent effect on the airflow therethrough in order to achieve mixing.

In this manner, the heat of the non-recirculated portion of the oxidation apparatus exhaust can be utilized to heat the pressroom. However, in this instance, a heat exchanger is necessary to assure that the air in the pressroom heating system is completely free of evaporated solvents because same is being introduced into an area where pressroom personnel are present.

The present invention is, therefore, a system by which the heat from the oxidation apparatus exhaust can be utilized, without heat exchangers or intermediate mediums, to heat the air supply to the dryer sections, thereby eliminating the necessity of separate heating apparatus for each of the dryer sections. In this manner, the overall energy consumption of the press is reduced in an economically feasible manner. Further, the above objective is accomplished in a completely safe fashion, because the recirculation system is entirely isolated from the pressroom. In order to provide further efficiency, the heat from the non-recirculated portion of the oxidation apparatus exhaust may be utilized, by means of a heat exchanger, to heat the pressroom.

Claims

1. An energy recovery method for use in a solvent evaporation system of the type comprising an enclosed solvent evaporation area, wherein heated air is supplied to evaporate solvents, solvent oxidation means operably connected to receive the exhaust from the solvent evaporation area and for removing the evaporated solvents therefrom, the method comprising the steps of: recirculating the oxidation means exhaust to the solvent evaporating area enclosure and utilizing same as a portion of the air supply thereto to provide heat to promote solvent evaporation within the solvent evaporation area.

2. The method of Claim 1 further comprising the steps of sensing the temperature within the enclosed evaporation area and regulating the flow of oxidation means exhaust introduced into the evaporation area, in accordance with the sensed temperature.

3. The method of Claim 1 further comprising the step of venting the non-recirculated exhaust of the oxidation means to the atmosphere so as to eliminate same.

4. The method of Claim 2 further comprising the step of venting the non-recirculated exhaust of the oxidation means to the atmosphere so as to eliminate same.

5. The method of Claim 1 further comprising the step of averaging the temperature of the exhaust of the oxidation means so as to provide recirculated air of substantially constant temperature.

6. The method of Claim 4 further comprising the step of averaging the temperature of the exhaust of the oxidation means so as to provide recirculated air of substantially constant temperature.

7. The method of claim 2 further comprising the step of utilizing heat from the exhaust of the oxidation means to heat the room in which the solvent evaporation takes place.

8. The method of Claim 7 wherein the step of utilizing the heat from the exhaust of the oxidation means comprises the step of transferring heat from the oxidation means exhaust to fresh air and utilizing the heated fresh air to heat the room.

9. The method of Claim 8 wherein the step of utilizing the heat from the exhaust of the oxidation means further comprises the steps of mixing the heated fresh air with non-heated fresh air, sensing the temperature of the mixed air and regulating the proportions of heated and non-heated fresh air in the mixture, in accordance with the sensed temperature.

10. The method of Claim 2 further comprising the step of utilizing heat from the exhaust of the oxidation means to heat the room in which the solvent evaporation takes place.

11. The method of Claim 10 wherein the steps of utilizing the heat from the exhaust of the oxidation means comprises the step of transferring heat from the oxidation means exhaust to fresh air and heating the room with the fresh air.

12. The method of Claim 11 wherein the step of transferring heat from the oxidation means occurs in sequence prior to the step of venting the non-recirculating exhaust of the oxidation means to the atmosphere.

13. The method of Claim 11 wherein the step of transferring heat from the oxidation means occurs in sequence subsequent to the step of recirculating the exhaust of the oxidation means to the solvent evaporation area.

14. The method of Claim 13 wherein the step of transferring heat from the oxidation means occurs in sequence prior to the step of venting the output of the oxidation means to the atmosphere.

15. The method of Claim 1 further comprising the step of directing the recirculated air to the surface where the evaporation is taking place, so as to lower that vapor pressure at that surface.

16. The method of Claim 1 wherein the solvent is evaporated from a web which passes through the evaporation area enclosure.

17. The method of Claim 1 wherein the evaporation area is the dryer section of a printing press or the like.

18. Apparatus for energy recovery in a solvent evaporation system comprising an enclosed area in which solvent evaporation takes place through the use of a supply of heated air, solvent oxidation means operably connected to receive the solvent laden air from said enclosed area and remove the solvents therefrom and means for recirculating the exhaust from said oxidation means to form a regulated portion of the supply of heated air for said enclosed area.

19. The apparatus of Claim 18 further comprising means for sensing the temperature within said enclosed area and means for regulating the flow of exhaust air from said oxidation means in accordance with said sensed temperature.

20. The apparatus of Claim 18 further comprising means for venting the non-recirculated exhaust of the oxidation means to the atmosphere so as to eliminate same.

21. The apparatus of Claim 19 further comprising means for venting the non-recirculated exhaust of the oxidation means to the atmosphere so as to eliminate same.

22. The apparatus of Claim 18 further comprising means for averaging the temperature of said exhaust air so as to recirculate air of substantially constant temperature to the enclosed area.

23. The apparatus of Claim 21 further comprising means for averaging the temperature of said exhaust air so as to recirculate air of substantially constant temperature to the enclosed area.

24. The apparatus of Claim 18 further comprising means for utilizing heat from said exhaust to heat the room in which the enclosed area is located.

25. The apparatus of Claim 24 wherein said heat utilizing means comprises a heat exchanger, a first source of fresh air and means for directing said exhaust air and said fresh air from said first source through said heat exchanger such that heat from said exhaust is transferred to said fresh air.

26. The apparatus of Claim 25 further comprising a second source of fresh air, means for mixing air from said second source and said heated air from said exchanger, means for sensing the temperature of said mixed air and means for regulating the proportions of said heated air and said fresh air from said source in accordance with said sensed temperature.

27. The apparatus of Claim 19 further comprising means for utilizing heat from said exhaust to heat the room in which the enclosed area is located.

28. The apparatus of Claim 27 wherein said heat utilizing means comprises a heat exchanger, a first source of fresh air and means for directing said exhaust air and said fresh air from said first source through said heat echanger such that heat from said exhaust is transferred to said fresh air.

29. The apparatus of Claim 28 wherein said heat exchanger is located prior to said venting means.

30. The apparatus of Claim 28 wherein said heat exchanger is located subsequent to the recirculating means.

31. The apparatus of Claim 29 wherein said heat exchanger is located subsequent to the recirculating means.

32. The apparatus of Claim 18 wherein said enclosed area comprises a supply conduit having an opening in close proximity to the evaporation surface and means for operably connecting said recirculating means to said supply conduit.

33. The apparatus of Claim 32 wherein said area further comprises an internal recirculation loop, the output side of which feeds said supply conduit, said recirculation means output being situated within said area in close proximity to the input to said internal recirculation loop.

34. The apparatus of Claim 18 wherein the solvent is evaporated from a web which passes through the evaporation area enclosure.

35. The apparatus of Claim 18 wherein the evaporation area is the dryer section of a printing press or the like.

36. An energy recovery method substantially as hereinbefore described.

37. Apparatus substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

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